Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Inquiry Regarding Carrier Current Systems, Including Broadband Over Power Line Systems	)	ET Docket No. 03-104
	)	
	)	

REPLY COMMENTS

The Wireless Communications Association International, Inc. ("WCA"), by its counsel, hereby submits its reply comments in response to the Commission's *Notice of Inquiry* ("*NOI*") in the above-captioned proceeding.

The initial comments in this proceeding affirm that wired and wireless service providers have substantial concerns about harmful interference from Broadband over Power Line ("BPL") systems. Indeed, providers of wireless broadband service,[1] landline telephone service,[2] DSL service,[3] television broadcast service,[4] Radio Astronomy Service,[5] and amateur radio service[6] have warned the Commission of the risk to their operations from ubiquitously deployed BPL systems. Equally important, commenting parties have highlighted the dearth of meaningful data

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[1] *See* Comments of Sprint Corporation, ET Docket No. 03-104 (July 7, 2003).

[2] *See* Comments of Qwest Communications International, Inc., ET Docket No. 03-104 (filed July 7, 2003) ("Qwest Comments").

[3] See Verizon Comments, ET Docket No. 03-104 (filed July 7, 2003) ("Verizon Comments").

[4] *See* Joint Comments of The Association For Maximum Service Television, Inc. and the National Association of Broadcasters, ET Docket No. 03-104 (filed July 7, 2003) ("MSTV/NAB Comments").

[5] *See* Comments of the National Academy of Sciences' Committee On Radio Frequencies, ET Docket No. 03-104 (filed July 7, 2003).

[6] *See* Comments of ARRL, The National Association For Amateur Radio, ET Docket No. 03-104 (filed July 7, 2003).

on the interference potential of BPL technology, and have urged the Commission to develop the record further on that issue before unleashing BPL systems into the marketplace with minimal technical restrictions.[7]

WCA shares these concerns. Having had an opportunity to study the matter in greater detail and poll its member vendors, WCA has concluded that BPL systems have the potential to cause destructive interference even where BPL devices are located at relatively long distances from indoor or outdoor wireless broadband customer equipment. Confirmation of this point is provided in the attached engineering statement provided by Hardin & Associates, Inc. (the "Hardin Statement," attached hereto as Exhibit 1). As discussed therein, BPL may cause both radiated and conducted interference to wireless broadband customer equipment. Radiated interference arises from the fact that a BPL device is for all intents and purposes an intentional radiator, *i.e.*, by coupling RF energy into the power line, a BPL device effectively transforms a power line into an antenna that radiates signal into the air. Conducted interference occurs where RF energy within the power supply is transmitted directly into a victim wireless broadband device's circuitry. Also, BPL may cause interference on a wireless broadband device's RF (transmitted) frequencies and its Intermediate Frequencies ("IF"). BPL interference on RF

[7] *See, e.g.,* Verizon Comments at 6 ("Unlike telecommunications services and equipment, there are no industry standards or technical requirements for the operation of BPL. Before taking any regulatory action, the Commission should encourage the development of industry standards for BPL."); MSTV/NAB Comments at 5-6 ("[A] low number of consumer complaints does not equate to a sound technical record, nor does a complaint trigger an expeditious remedy by the interfering entity. Rather, BPL technology must be subjected to the rigorous testing needed to determine whether it is effective in *preventing* interference in real-world settings . . . .") (emphasis in original); Qwest Comments at 4 ("[T]he Commission should require potential BPL providers to set forth how they propose to provide the service and furnish technical documentation demonstrating that they have taken all necessary steps to prevent such interference. This documentation must be made available to all interested parties, so they can satisfy themselves and the Commission that their services are adequately protected.").

frequencies may be seen as co-channel interference, and a typical wireless broadband device may experience IF interference from BPL at frequencies ranging from 222-408 MHz.[8]

The Hardin Statement calculates that a 1 dB degradation in receiver noise floor will result in a 10% to 20% reduction in a wireless broadband system's coverage area, depending on the selected propagation model. Importantly, the Hardin Statement further demonstrates that operation of BPL systems with no frequency limitations and under the relaxed emission limits proposed in this proceeding by Satius, Inc. will degrade the noise floor by a factor many times greater than 1 dB.[9] For example, a BPL system will cause a 64.15 db degradation in the noise floor even if located 100 meters from a wireless broadband base station operating in the 2600 MHz band, and a 49.15 dB degradation in the noise floor if located 100 meters from a wireless broadband handset operating in the 2600 MHz band. And, where an indoor MDS modem receives signals in the 2150 MHz band, a BPL system will cause harmful IF interference (in this case a 16.64 dB reduction in the noise floor) if separated from the modem by up to 5 meters.

Finally, WCA is working directly with its member vendors to develop a more quantitative assessment of the conducted interference BPL systems will cause to wireless broadband systems. It is clear, however, that such interference may render wireless broadband service inoperable in many cases. At the heart of the problem is the fact that commercially available power supplies typically do not filter high frequency emissions from an AC power

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[8] For example, some wireless broadband systems use DOCSIS cable modems which have an IF frequency of 5-42 MHz. In standard configurations, power generated from an inexpensive linear transformer supply is multiplexed onto an indoor-outdoor IF cable along with signals in the 5-42 MHz band and 200-600 MHz band. Since the transmit IF frequencies are in the same band as a standard BPL system (*i.e.*, below 30 MHz), there is significant potential for interference if BPL signals are delivered through the AC/DC adapter and onto the IF cable.

[9] *See* Comments of Satius, Inc., ET Docket No. 03-104 (filed July 7, 2003).

source. Hence, if an AC power source contains high frequency BPL signals, a power supply may pass these signals onto a wireless broadband device's sensitive RF and IF circuitry. In turn, this may cause a variety of technical anomalies in wireless broadband equipment, including but not limited to modem transmissions outside of ranges permitted by the Commission's Rules, degraded receiver noise floor, oscillator drift and other such phenomena. Furthermore, if BPL signals appear on the DC bias in the IF circuitry, the resulting interference may degrade the reception ability of a wireless broadband modem to the point where it is rendered useless.

In sum, the Commission's Spectrum Policy Task Force emphasized that "a level of certainty regarding one's ability to continue to use spectrum, at least for some foreseeable period, is an essential prerequisite to investment, particularly in services requiring significant infrastructure and lead time."[10] This is most certainly the case with respect to wireless broadband service, and thus it is imperative that the Commission ensure that BPL systems do not create any threat of harmful interference on licensed or license-exempt spectrum that is the lifeblood of existing and future wireless broadband operations. Accordingly, WCA requests that the Commission, in cooperation with all affected parties, undertake whatever data collection and laboratory testing is necessary to fully understand the interference risks posed

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[10] Report of the Spectrum Policy Task Force, Federal Communications Commission, ET Docket No. 02-135, at 23 (November 2002).

by BPL systems, and that any such activities be undertaken prior to issuance of a *Notice of Proposed Rulemaking* in this proceeding.

Respectfully submitted,

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EXHIBIT 1

Engineering Statement Regarding the Notice of Inquiry (ET Docket 03-104) Regarding Broadband Over Power Line Systems

Introduction

Hardin and Associates, Inc has been retained by the Wireless Communications Association International, Inc. ("WCA") to review and respond to the Commission's Notice of Inquiry ("NOI") regarding Broadband Over Power Line ("BOPL") systems. WCA believes that BOPL technology has the potential to cause widespread harmful interference to wireless broadband systems operating on licensed and license-exempt spectrum, particularly if the Commission relaxes its Part 15 rules as recommended by certain parties in this proceeding.

Background

WCA represents operators and vendors that provide or support the provision of wireless broadband service over, *inter alia*, licensed spectrum in the 2.1 GHz, 2.3 GHz and 2.5 GHz (2500-2690 MHz) bands and license-exempt spectrum in the 902-928 MHz, 2.4 GHz and 5 GHz bands. WCA thus has a direct and immediate interest in ensuring that any rules the Commission adopts for BOPL do not create an unacceptable risk of harmful interference.

In the NOI, the Commission notes that it has permitted BOPL carriers to operate on frequencies as high as 80 MHz on an experimental basis. However, at least one party, Satius, Inc. ("Satius") has asked the Commission to permit BOPL operations on much higher frequencies (above 200 MHz). At the same time, Satius also proposes to propose to relax the emissions limits for intentional radiators (which would include BOPL) set forth in Section 15.209 of the Commission's Rules. The current limits are as follows:

Figure 1

Frequency (MHz)	Field Strength (microvolt/meter)	Measurement Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Satius' proposal, on the other hand, would relax these emissions limits for outdoor operation to:

Figure 2

Frequency (MHz)	Field Strength (microvolt/meter)	Measurement Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-54	500	300
54-88	100	30
88-216	150	30
216-470	500	300
470-960	200	30
Above 960	500	300

Satius is also requesting that the Commission relax the emission limits for indoor transmissions to:

Figure 3

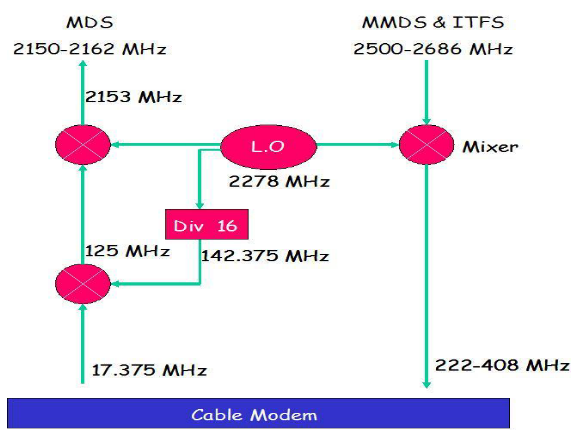
Frequency (MHz)	Field Strength (microvolt/meter)	Measurement Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-54	500	30
54-88	100	3
88-216	150	3
216-470	500	30
470-960	200	3
Above 960	500	30

WCA is very concerned that operation of BOPL systems at higher frequencies, combined with any relaxation of the Commission's Part 15 emission limits (either under Satius' proposal or otherwise), will cause harmful BOPL interference to wireless broadband service over wide areas of the country. There are two potential forms of interference from BOPL, radiated and conducted. Radiated interference arises from the fact that a BOPL device is for all intents and purposes an intentional radiator. By coupling RF energy into the power line, a BOPL device effectively transforms the power line into an antenna that radiates signal into the air (this immediately distinguishes BOPL from coaxial cable – the latter is shielded and thus generally prevents such emissions except at very low levels). Conducted interference occurs where RF energy within the power supply is transmitted directly into a victim receiver's circuitry – as discussed below, the common inability of power sources to "choke off" RF energy at higher frequencies is the primary driver of the conducted interference problem.

BOPL interference also may occur at RF (transmitted) frequencies and at Intermediate Frequencies ("IF") of a wireless broadband device. For example, Figure 4 below demonstrates that interference from BOPL systems may be seen by the receiver as cochannel interference at RF frequencies in the 2500-2696 MHz band. However, since Satius proposes that the Commission permit BOPL systems to operate at frequencies *anywhere* above 960 MHz under less stringent emission limits, the Satius proposal creates the risk that components of BOPL signals will radiate along power lines at frequencies above and below 960 MHz and cause harmful interference to wireless broadband services in the 902-928 MHz, 2.1 GHz, 2.3 GHz, 2.4 GHz and 5 GHz bands.

In addition, Figure 4 shows where the IF components of a typical broadband wireless device exist, and that interference can occur from 222-408 MHz at IF. Signal also may bleed into the oscillators to and distort the outbound signal at 17.375 MHz and at 125 MHz.

Figure 4



The potential harm to wireless broadband service in this situation is patent, and should give the Commission great pause before it even considers relaxing its technical rules for the benefit of BOPL systems. Unacceptable BOPL emissions levels will result in degraded receiver performance in wireless broadband systems. This equates to reduced coverage areas, dropped calls or sessions, the inability to make calls or connections and overall system performance degradation. The following analysis describes in greater detail how Satius's proposal will cause harmful interference to wireless broadband operations, and the potential damage that interference will cause to wireless broadband service.

Interference Analysis Methodology

The analysis set forth below determines the measurable impact of BOPL emission levels on system performance by calculating the required physical separation distance between a victim receiver and the interfering BOPL transmitter. For purposes of this paper, a measurable impact on system performance will be defined as the BOPL system's quantitative impact on a victim receiver's noise floor.

The following example shows the impact of 1 dB degradation in receiver noise floor and the corresponding reduction in coverage area. If we assume a standard PCS like channel bandwidth of 1.25 MHz and a noise figure of 5 dB, the thermal noise floor for a typical base station receiver is calculated at –108.03 dBm. If we now assume a typical 15 dBi base station antenna gain and a handset with 1 watt (30 dBm) EIRP, the amount of path loss it would take to reach the noise floor is 153 dB. This path loss budget can be translated into a maximum coverage distance through the use of a propagation model. Assuming circular or omni-directional coverage, this maximum coverage distance can then be translated into a maximum possible coverage area as shown in Figure 5. The impact of 1 dB degradation in receiver performance is determined by recalculating the maximum coverage area with the path loss budget reduced from 153 dB to 152 dB.

As can be seen in Figure 5, a 1dB degradation in receiver noise floor will result in a 10% to 20% reduction in coverage area, depending upon the selected propagation model:

Figure 5

Noise Floor (1.25 MHz Bandwidth)	-113.03	dBm
Base Station Rx Noise Figure	5	dB
Total Noise Power	-108.03	dBm
Base station Rx Ant Gain	15	dBi
Handset Tx Power	30	dBm
Carrier Frequency	2160	MHz
Required C/N	0	dB
Path Loss Budget to Noise Floor	153	dB
Coverage Area, No Interference		
Free Space Path Loss Only	276,269.1	Mi
ITU Outdoor-to-Indoor Path Loss	1.6	Mi
ITU Vehicular Path Loss	21.1	Mi

Coverage Area, With Interference		
Free Space Path Loss Only	219,448.4	Mi
ITU Outdoor-to-Indoor Path Loss	1.4	Mi
ITU Vehicular Path Loss	18.7	Mi
Percent Reduction in Area		
Free Space Path Loss Only	20.6%	Mi
ITU Outdoor-to-Indoor Path Loss	10.9%	Mi
ITU Vehicular Path Loss	11.5%	Mi

Radiated Interference

Figure 6 below is an analysis showing the potential for interference from BOPL to RF signals of a Multipoint Distribution Service ("MDS") base station receiver operating in the 2600 MHz band. This analysis assumes that the subscriber's handset is operating outdoors, and that the BOPL system is radiating at Satius's proposed outdoor emission limits (Figure 2 above) in the 2600 MHz band. The following results confirm that a BOPL system separated from an MDS base station by 100 meters will cause a 64.15 dB degradation in the noise floor, a catastrophic level of interference for wireless broadband system.

Figure 6

Interference to MDS Base Station	
Powerline Parameters	
Frequency (MHz)	2600.00
Field Strength (uV/m)	500.00
Field Strength (dBuV/m)	53.98
Distance (meters)	300.00
Interfer EIRP (dBW/ 10KHz)	-31.25
Interfer EIRP (dBW)	-10.28
BWA Parameters	
Receiver Bandwidth (MHz)	1.25
Noise Figure (dB)	5.00
Antenna Gain (dBi)	15.00
Noise Floor (dBW)	-138.03
Interference Results	
Distance from BPL Interfer (meters)	100.00
Interference Level from BPL (dBW)	-73.88
Noise Floor Increase (dB)	64.15

Figure 7 below is an analysis showing the potential for interference from BOPL to RF signals of an MDS handset receiver located in the 2600 MHz band. Again, this analysis assumes that the handset is operating outdoors, and that the BOPL system is radiating at the outdoor emission limits proposed by Satius. As the results show, in this situation a BOPL system separated from an MDS handset by 100 meters causes a 49.15 dB degradation in the noise floor.

Figure 7

Interference to MDS Handset	
Powerline Parameters	
Frequency (MHz)	2600.00
Field Strength (uV/m)	500.00
Field Strength (dBuV/m)	53.98
Distance (meters)	300.00
Interfer EIRP (dBW/ 10KHz)	-31.25
Interfer EIRP (dBW)	-10.28
BWA Parameters	
Receiver Bandwidth (MHz)	1.25
Noise Figure (dB)	5.00
Antenna Gain (dBi)	0.00
Noise Floor (dBW)	-138.03
Interference Results	
Distance from BPL Interfer (meters)	100.00
Interference Level from BPL (dBW)	-88.88
Noise Floor Increase (dB)	49.15

Figure 8 below is an analysis showing the potential for interference from BOPL to RF signals of an MDS nomadic modem receiver located in the 2600 MHz band. The analysis assumes that the receiver is operating indoors and that the BOPL system is radiating at Satius's proposed indoor emission limits (Figure 3 above). As the results show, a BOPL system separated from an MDS base station by 5 meters causes a 64.17 dB degradation in the noise floor.

Figure 8

Interference to MDS Modem	
Powerline Parameters	
Frequency (MHz)	2600.00
Field Strength (uV/m)	500.00
Field Strength (dBuV/m)	53.98
Distance (meters)	30.00
Interfer EIRP (dBW/ 10KHz)	-51.25
Interfer EIRP (dBW)	-30.28
BWA Parameters	
Receiver Bandwidth (MHz)	1.25
Noise Figure (dB)	5.00
Antenna Gain (dBi)	9.00
Noise Floor (dBW)	-138.03
Interference Results	
Distance from BPL Interfer (meters)	5.00
Interference Level from BPL (dBW)	-73.86
Noise Floor Increase (dB)	64.17

Finally, Figure 9 below shows the potential for interference from BOPL to IF signals at 222 MHz if an indoor MDS modem receives signals in the 2150 MHz band. As the results show, BOPL system separated from an MDS modem by 5 meters causes 16.64 dB degradation in the noise floor, assuming the electronics are shielded by 60 dB from the outside RF environment.

Figure 9

IF Interference to MDS Modem	
Powerline Parameters	
Frequency (MHz)	222.00
Field Strength (uV/m)	500.00
Field Strength (dBuV/m)	53.98
Distance (meters)	30.00
Interfer EIRP (dBW/ 10KHz)	-51.25
Interfer EIRP (dBW)	-30.28
BWA Parameters	
Attenuation from Shielding (dB)	60
Receiver Bandwidth (MHz)	1.25
Noise Figure (dB)	5.00
Antenna Gain (dBi)	0.00
Noise Floor (dBW)	-138.03
Interference Results	
Distance from BPL Interfer (meters)	5.00
Interference Level from BPL (dBW)	-121.49
Noise Floor Increase (dB)	16.64

Conducted Interference

Conducted interference is that resulting from the inability of a wireless broadband device to “choke off” high frequencies delivered into its circuitry from its power supply. The interference from BOPL signals that are not trapped at the power supply may cause anomalies in broadband wireless equipment. These anomalies may include signal transmissions outside of ranges permitted by the Commission’s rules, degraded receiver noise floor, oscillator drift and other such phenomena.

Power supplies that are in use today typically do not filter high frequency emissions from the AC power source. Hence, if an AC power source contains high frequency BOPL signals, the power supply may pass these signals into the sensitive IF and RF circuitry. Many manufacturers of wireless broadband customer equipment use 5-42 MHz as the IF frequency range for upstream transmissions and 200-600 MHz as the IF frequency range for downstream transmissions. If BOPL signals appear on the DC bias in the IF circuitry, the distortion of the modem’s transmissions could be catastrophic. The distortions may also degrade the reception ability of the modem to the point where the device is useless.

WCA is in the process of working directly with its vendors to develop a more quantitative analysis of how destructive conducted interference may be to existing equipment. At a minimum, however, the Commission should require joint laboratory testing between affected parties and the BOPL industry to supplement the record on this critical issue.

Conclusions

Given the extreme magnitude of interference and receiver degradation discussed above, the Commission should not even consider permitting BOPL operations on higher frequencies (i.e., above 30 MHz) or consider any relaxation of the Part 15 emission limits for BOPL systems given the current state of the record. The interference impact can be above 60 dB in locations where BOPL facilities are in close proximity to wireless broadband systems, and interference also may occur into the IF frequencies that many wireless broadband systems use for up conversion and down conversion of signals. Furthermore, high frequency BOPL signals from conventional AC power sources may produce severe conducted interference that may produce signals outside a wireless broadband device’s authorized transmit band, and may also degrade receiver performance. Ultimately, the BOPL community must work directly with the wireless broadband industry to find a workable solution to these problems.

Certification of Engineer

I, James C. Cornelius, P.E., am a Professional Engineer licensed in the Commonwealth of Virginia and my credentials are a matter of record with the Federal Communications Commission. The foregoing analysis was prepared by me or under my direct supervision. The information contained herein is true and correct to the best of my knowledge, information and belief.

__________/s/_________________
James C. Cornelius, P.E.

August 20, 2003